Universal Adapters: Terminology Standards Enable Meaningful Data Exchange

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Standardized clinical terminologies are critical connectors that allow systems to exchange health information.

In the winter of 1904 a major fire broke out in Baltimore, MD. The resulting damage—an entire swath of the downtown destroyed—was blamed largely on a lack of uniform threads for fire hoses and hydrants:

> Engine companies, arriving by special train from Washington within 3 hours after the fire began, found themselves helpless when their hoses would not fit Baltimore hydrants. As one by one, completely fire-proofed buildings burned like torches all that day and the next, and the fire raced through block after block of the business district, additional fire units from the nearby counties, from New York, Philadelphia, Annapolis, Wilmington, Chester, York, Altoona, and Harrisburg, arrived in the city only to discover that few of their hoses matched any other or fitted the local hydrants. …[A]t no time was there any shortage of water. … 1,526 buildings and all electric light, telegraph, telephone, and power facilities in an area of more than 70 city blocks in the business district were razed before the fire burned out, 30 hours after it began.[1]

HIM systems today have a similar problem connecting. Massive amounts of data flow through information systems, but they lack the critical connections required for safe and effective exchange of information. And like the hose and hydrant threads of 1904, interoperability in health information exchange is a serious matter that affects human lives.

How Terminologies Support Interoperability

Meaningful data exchange requires standardized terminologies for the capture of clinical data. An Institute of Medicine report states, "At the most basic level, data standards are about the standardization of data elements: (1) defining what to collect, (2) deciding how to represent what is collected (by designating data types or terminologies), and (3) determining how to encode the data for transmission."[2] Thus, standard terminologies are an essential part of interoperability.

Specifically, clinical terminologies are vital to health information systems achieving semantic interoperability because they provide standardized meanings of concepts and a sense of context for the data collected. In other words, standard terminologies create the universal adapter that allows data to flow between locations and be reliable enough to save lives.

There are different levels of interoperability. **Technical interoperability** is the basic ability of systems to successfully send and receive data. Circumstances at Walter Reed Army Medical Center, first reported in February 2007, illustrate the importance of structured and standardized data content in enabling technical interoperability.[3]

At the time, 16 different information systems were used to process soldiers' medical forms, but very few could communicate with each other. Three personnel databases existed, but they could not interact with the payment and other systems housing soldiers' military records. Patients, often suffering from traumatic brain injuries, struggled to manage their own care and follow-up. Records were lost, requiring soldiers to prove their service in order to obtain medical treatment. Patients languished for an average of ten months, and some as long as two years, waiting for decisions to be made regarding military status, disability benefits, and transfer to the Veterans Administration for follow-up care.

The subsequent investigation resulted in the Military Medical Tracking System, which provides a single view of all medical information, personnel records, and follow-up appointments. The Department of Defense is currently planning a major change in the way it manages electronic health records, including a new service-oriented architecture designed to be interoperable with the Veterans Administration electronic health record system.[4]

Semantic interoperability is the ability to exchange data with meaning. Its reliance on standardized terminologies is illustrated by the following common clinical scenario.

Diabetic ketoacidosis, a life-threatening emergency, occurs when the body does not get enough glucose and begins to break down fat for energy. Patients are commonly dehydrated and may exhibit elevated serum potassium (K+) concentrations due to an extracellular shift of potassium. If extracellular potassium begins to rise, the electrical potential across the membrane system is altered, causing cardiac dysfunction. This first appears as peaked T-waves on EKG and can lead to ventricular fibrillation, which can be fatal.

Treating diabetic ketoacidosis involves the use of insulin to reduce blood sugar. This causes a precipitous shift of the K+ from circulating extracellularly back into cells, risking hypokalemia instead. Thus, patients are simultaneously given IV potassium chloride to maintain normal circulating K+ levels. Calculations of how much potassium chloride to administer depend on the initial serum potassium level.

Normal potassium ranges vary among reference laboratories as illustrated below:

Lab 1 3.2 - 5.5 mmol/L
Lab 2 3.5 - 5.2 mmol/L
Lab 3 3.3 - 4.9 mmol/L
Lab 4 3.5 - 5.1 mmol/L

Thus, an initial laboratory result of 5.6 mmol/L reported by the first laboratory appears to be quite elevated, but is just out of reference range, as opposed to lab 3's normal range. This increases the risk of a physician miscalculating the appropriate dosage of potassium to administer. Additionally, laboratory results are reported at mmol/L, not mEq/L. In this case it is a one-to-one ratio, but units of measure do vary among laboratories as well.

The Burning Need for HIM Involvement

Achieving interoperability brings a variety of challenges to HIM professionals and the systems they use. As an example, consider issues with respect to creating and maintaining an accurate list of a patient's problems. Promoting interoperability through the use of a controlled terminology requires:

- Selecting the standard
- Constraining the reference information
- Creating a lookup algorithm that "thinks like me"
- Handling changes to the reference terminology
- Working with pre- and postcoordinated concepts

Each is discussed in turn below.

Selecting the Standard

The Continuity of Care Document (CCD) is a standard format for the exchange of basic patient information such as demographics, medications, and allergies. It was developed by standards development organizations ASTM International and Health Level Seven, and it was recommended for use to the US Department of Health and Human Services by the Healthcare Information Technology Standards Panel, the public-private body charged with identifying and harmonizing the data and technical standards necessary to advance health IT adoption. Federal recognition means that government agencies may only purchase health IT systems that comply with the standard. On the private side, the Certification Commission for Healthcare Information Technology has specified use of the standard as a criterion for its certification of ambulatory products.

The CCD specifies the Systematized Nomenclature of Medicine Clinical Terms (SNOMED CT, often SNOMED for short) as the terminology standard for use in defining problems and vital signs. Given this requirement, selecting SNOMED as the terminology standard for problems makes sense. However, few EHR systems, commercial or home-grown, use it in clinical settings, so little information is available on how it has been accepted.

Anecdotal evidence suggests that SNOMED display terms are not uniformly acceptable to clinicians, who are more comfortable recording that a patient has cancer than that he or she has a malignant neoplasm. Choosing SNOMED as the standard requires linking local vocabularies to standard terminologies. Interface terminologies—those with clinician-friendly local terms—must be mapped to standard terminologies for semantic equivalency.[5,6] HIM involvement is crucial for coordination, maintenance, and educational outreach.

Constraining the Reference Information

SNOMED contains more than 300,000 concepts, which provides a very large pool of information from which to select the concept that best describes the problem. In fact, there are whole groups of concepts that are unlikely to be needed in an EHR problem list module, such as those that refer to nonhumans. Limiting the pool of available concepts to something manageable will help make the selection of appropriate problems easier.

The Food and Drug Administration, Department of Veterans Affairs, and Kaiser Permanente produced such a subset of approximately 16,000 SNOMED concepts specifically for use with problem lists. Available free of charge and without licensing restrictions, the subset is available for download from the National Library of Medicine.[7]

Organizations may choose to adopt the set or create one that meets their own needs. HIM professionals should become familiar with subsets in order to standardize or constrain data prior to its use in clinical documentation and therefore help their organizations gain ground on process interoperability.

Defining Interoperability

The Institute of Electrical and Electronic Engineers standard IEEE-90 defines interoperability as the “ability of two different systems to exchange data so that it is useful.”[1] The definition provides a good starting point to discuss the various types of interoperability.

Arguably, providing a photocopy of a paper-based record that can be read and interpreted by another person (in this instance, a “system”) achieves a minimal level of interoperability. Information is successfully exchanged and used, but the use is basic and the process is inefficient, costly, and prone to error.

Consider a large HMO. Say there are 44 different scanned master records from which one, and only one, actual report can “hang.” Multiply it across many instances of operations and hundreds of paper documents coming in to be scanned for millions of members.

Depending on workflows within the organization, a lab test could be scanned in under the header of “diagnostic testing scanned report,“ whereas in another department the lab test could be scanned under the header of “nonspecific lab scanned result.“

The Department of Defense and Department of Veterans Affairs identified three levels of interoperability based upon the format of the data being shared. Their view of interoperability ranged from paper-based data at the lowest end; to unstructured, viewable, electronic data in the middle; to structured, viewable electronic data at the top.[2] Sharing of electronic computable data is the highest level of interoperability.

Within the context of electronic systems, interoperability broadly refers to the “ability of one computer system to exchange data with another computer system,“ according to the National Committee on Vital and Health Statistics.[3]

A 2006 presidential order promoting quality and efficient healthcare offered a more detailed definition: “The ability to communicate and exchange data accurately, effectively, securely, and consistently with different information technology systems, software applications, and networks in various settings, and exchange data such that clinical or operational purpose and meaning of the data are preserved and unaltered."[4]

Recognizing a Hierarchy

Although different groups categorize interoperability into different levels, most approaches recognize a hierarchical structure moving from a basic to more sophisticated and standardized levels. The US Department of Health and Human Services describes basic, functional, and semantic levels of interoperability. Basic interoperability is achieved when a message is able to be sent by one computer and received by another. The receiving computer (or system) is not able to interpret the transmitted data.

Functional interoperability requires a defined structure or format to the data (or message) being sent. At this level, the receiving system understands the nature of the data; for example, that the information being sent contains vital sign results. At the functional level, the receiving system has a sense of the information but cannot fully interpret it. For example, the receiving system may not understand either the scale or method used to measure body temperature (e.g., Fahrenheit or Celsius, oral or skin).

With semantic interoperability, the sending and receiving computer systems have a shared understanding of the data being exchanged. At this level, the receiving system understands both the structure of the message and the content of the data contained within it. For example, each system would know the scale used to measure a lab result and thus whether to interpret the result as normal or abnormal.

A Health Level Seven work group identified three broad types of interoperability: technical, semantic, and process.[5] Technical interoperability relates to the conveyance of data, not its meaning. Semantic interoperability is the "ability of information shared by systems to be understood." The work group further recognized semantic interoperability to be a multilevel concept dependent upon level of agreement between data content terminologies and the model or templates used by the sending and receiving systems.

Process interoperability is an emerging concept that incorporates the social and workflow components of a system. It deals with the ability to integrate information exchanged into computer systems within an actual work setting. This level of interoperability represents a highly functional healthcare system armed with reliable quality information to deliver the highest quality of care.

Notes

1. *IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries*. New York, NY: Institute of Electrical and Electronics Engineers, 1990.
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Creating a Lookup Algorithm That "Thinks Like Me"

Consider a user who enters a search term to find the appropriate coded term from a controlled terminology. She has in mind the problem she is looking for and expects to see it at the top of the returned list. Her expectations dictate what she types in, which may be an abbreviation, such as “CHF,” or a concept whose meaning is familiar to her, such as “Chlamydia.” To the user, the correct response is obvious, but to the controlled terminology, it may not be.

“CHF” is generally used to mean “congestive heart failure,” but it may also stand for “congenital hepatic fibrosis.” “Chlamydia” refers to both a chlamydial infection and to the organism or species. The controlled terminology may return a large list of potential matches, which may be acceptable in a Google search but which is unacceptable in an EHR, where busy users need to find what they are looking for quickly, easily, and precisely.

A well-prepared lookup program will be able to take multiple search terms—such as “breast CA,” “breast cancer,” or “cancer of the breast”—and return the same accurate and understandable response or limited set of choices for each of these search terms. Creating the algorithm to do this may require trial and error, persistence, and assistance from users who are willing to provide feedback. HIM professionals should be prepared to provide input during this process.

Handling Changes to the Reference Terminology and Software

The medical domain is constantly changing, regularly adding new treatments, diseases, and terms to describe them. The concepts in a terminology, therefore, are constantly being reviewed, updated, added, and retired. Updates to SNOMED are published twice a year and must be incorporated into local EHR systems.

Updates require advance planning on the part of the EHR software provider so that the meaning of a problem posted to a patient’s record does not change if the original SNOMED code stored is retired and replaced by a new code. The development and maintenance of institution-specific SNOMED reference sets may fall to HIM personnel due to their expertise in the use of coded data systems. Therefore, health information managers must plan to accept this responsibility as part of ensuring data integrity.

Working with Pre- and Postcoordinated Concepts

Some changes to a terminology affect how concepts are built. For example, there may be more than one way to identify a right elbow fracture using SNOMED. The terminology may have a code for “fracture,” one for the location, “elbow,” and a third for the side, “right.” These may be put together into a new postcoordinated code derived from the three individual codes for each of the three atomic concepts that comprise the problem.

However, in SNOMED there are examples of predefined terms with a single code representing a whole concept, such as “right elbow fracture.” It is possible to use one of these precoordinated terms as well as build a postcoordinated code that represents the same concept. When both codes are available and used, the challenge of interoperability is knowing that they represent the same concept.

Behind the scenes, whichever code is stored to represent the concept may need to map to an ICD-9-CM billing code, or it may need to be recognized by a rule that provides decision support based on the problem. HIM professionals should prepare to take on the task of setting up the system correctly, using a thoughtful process involving all stakeholders, so correction of errors or inconsistencies after the episode is closed can be avoided.

An Emerging Role for HIM

Electronic health record interoperability comes down to the need for standards to achieve an efficient way to access, share, and exchange healthcare data in a meaningful way. Interoperability and the use of a standard clinical terminology require careful planning and analysis by HIM professionals working with the software applications or systems in which they will be used. They can provide expertise to guide data up front and help retrieve the data by guiding query definitions, as well as deliver reports with meaningful patient data once it has been retrieved by queries.

It is also important to take into account the needs of clinician users and changes published to the terminology. HIM professionals can create bridges between the technical requirements for successful health information exchange and the workflow and terminology asset management changes required to make them operational.

The stream of healthcare data requiring management is huge; for most organizations it could be compared to drinking from a fire hose. Building in a foundation of standard terminologies with personnel at the ready to manage it will ensure data are routed to the intended destination and get the job done. HIM professionals should continue working toward the goal of achieving all levels of interoperability by advancing data content and terminology standards that supply the universal adaptors needed for meaningful data exchange.

Notes

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